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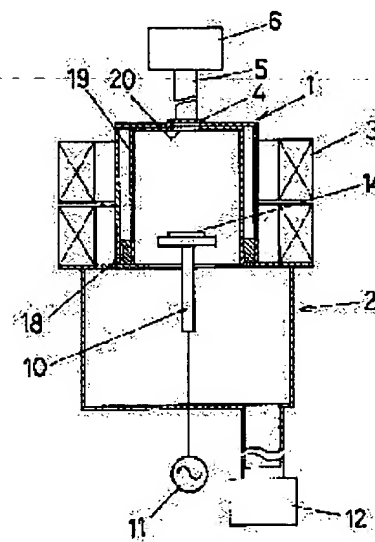
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## (54) MICROWAVE PLASMA PROCESSOR

### (57)Abstract:

**PURPOSE:** To provide a microwave plasma processor which can get stable plasma, and does not cause impurity pollution, and is favorable in maintainability.

**CONSTITUTION:** A plasma generation chamber 1 is provided in a row with a board carry chamber 2, and a microwave power source 6 is connected to the microwave introduction window 4 of the plasma generation chamber 1 through a waveguide tube 5, and a coreless solenoid coil 3 is installed outside of the plasma generation chamber 1. A carbonic tube 19 with a top is installed inside of the plasma generation chamber 1, and the inwall of the plasma generation chamber 12 is covered with a conductive material. The tube with a top 19 is connected electrically to the plasma generation chamber (made of stainless) through a conductive connection ring 18.



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DETAILED DESCRIPTION

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## [Detailed Description of the Invention]

[0001]

[Industrial Application] this invention relates to the microwave plasma treatment equipment which performs surface treatment, such as etching on the front face of a substrate, and thin film formation to a substrate, and which is used for manufacture processes, such as a semiconductor device, using the plasma generated using the electron cyclotron resonance phenomenon.

[0002]

[Description of the Prior Art] It is attached to conventional microwave plasma treatment equipment, and drawing 5 explains. Using the air core solenoid coil 3, in the plasma generating room 1 where the magnetic field of predetermined strength was impressed, the microwave plasma treatment equipment shown here introduces microwave via a waveguide 5 and the microwave introduction aperture 4 from the microwave power supply 6, causes a electron cyclotron resonance phenomenon, and plasma-izes the gas in the plasma generating room 1 introduced from the gas inlet (not shown) with the energy which this generated. Since the generated plasma is diffused in accordance with the emission magnetic field which the aforementioned magnetic field makes, it can extend an electric discharge field in the substrate conveyance room 2. The RF bias power supply 11 is connected to the substrate electrode holder 10 installed in the position in this electric discharge field, high-frequency voltage is impressed to the substrate electrode holder 10 from the RF bias power supply 11, and the substrate 14 which laid the ion in plasma on the substrate electrode holder 10 by the plasma accelerated and acquired is processed. 12 is a flueing system.

[0003] In processing a processed substrate with microwave plasma treatment equipment which was mentioned above, in order to avoid that the problem by which a substrate 14 is polluted with heavy metal when the spatter of the wall of the plasma generating room 1 is carried out by the generated plasma arises, the wall covering 16 made from a quartz is installed.

[0004]

[Problem(s) to be Solved by the Invention] There were the following faults with the above conventional microwave plasma treatment equipments.

(1) As shown in drawing 6 , in setting up the position of the substrate electrode holder 10 under plasma treatment in the plasma generating room 1, the ground electrode to RF power will not exist and the potential of plasma becomes unstable. Consequently, by \*\*\*\* plasma, since the ion in plasma, a radical composition ratio, abundance, and energy carry out aging or those spatial distribution changes, if etching, CVD, etc. are processed, an etching property and a membrane formation property will become unstable.

[0005] (2) As shown in drawing 5 , in setting up the position of the substrate electrode holder 10 under plasma treatment in the substrate conveyance room 2, the amount of [ between the wall surface by the side of the plasma generating room 1 of the substrate conveyance room 2 and the plasma generating room 1, and the substrate conveyance room 2 ] opening becomes a ground electrode to RF power. In this state, microwave and a magnetic field are made to act, plasma is generated, and by RF bias, when it is going to accelerate the ion in the aforementioned plasma, plasma will concentrate between a part of above-mentioned portion or the whole which constitutes a ground electrode, and the substrate electrode holder 10 which is a RF electrode. Since the amount of [ between the wall surface by the side of the ground portion 1 to RF power i.e., the plasma generating room of the substrate conveyance room 2 and the plasma generating room 1, and the substrate conveyance room 2 ] opening will receive a strong ion bombardment when starting, the substrate laid on the substrate electrode holder will be polluted with impurities, such as heavy metal which the spatter of these portions is carried out by ion, and they produce. Moreover, since plasma tends to incline toward the periphery section of the substrate electrode holder 10, if etching, CVD, etc. are processed, the homogeneity of the processing in a substrate tends to be spoiled. When the state of the plasma in a \*\*\*\* state is observed, the portion which plasma concentrates is changing and there is change of the inter-electrode voltage of RF bias further again. Bias voltage of the substrate by inter-electrode voltage ( $V_{pp}$ ) change of the aforementioned RF bias although aging and poor repeatability are accepted in the etching property and the membrane formation property of CVD (VDC) Change is considered to be the cause.

[0006] As an attempt which conquers the above troubles, invention of JP,60-158629,A printing shown in drawing 7 is known. 15 are a bell jar made from a quartz among drawing. In the equipment of drawing 7 , it is carried out by stabilizing impression of RF bias by installing the ground electrode 17 for RF bias. however -- in order for the ground electrode for RF bias to raise the effect in the microwave processor shown here -- plurality -- a concentric circle top -- arranging -- not installing -- it does not obtain, but an interval with both the ground electrodes for RF bias and a substrate electrode holder becomes narrow, the removal work of the resultant by plasma treatment etc. is done difficult, and it is based on the resultant which has not been removed -- there was a

trouble of producing contamination of a processed substrate

[0007]

[Means for Solving the Problem] It was made in view of the above troubles, and the stable plasma is acquired, and impurity contamination does not occur, and this invention aims at offering the good microwave plasma treatment equipment of maintenance nature.

[0008] In order that this invention may attain the above-mentioned purpose, wall surfaces other than the microwave introduction window part of a plasma generating room are worn by the wall which consists of conductive material other than a metal, and it is characterized by connecting this wall with ground potential electrically.

[0009] As the aforementioned conductive material, the material which consists of carbon, silicon, silicon carbides, or these composites can be used.

[0010]

[Function] In the microwave plasma treatment equipment of this invention, since the wall of a plasma generating room can be held to ground potential, when RF bias is impressed to a substrate electrode holder, a wall can act as a ground electrode for RF bias, and can attain stabilization of plasma.

[0011]

[Example] Hereafter, the example of this invention is explained with reference to drawing 1 -3.

[0012] Drawing 1 is microwave plasma treatment equipment of the 1st example. While having formed successively the plasma generating room 1 and the substrate conveyance rooms 2 and installing the air core solenoid coil 3 in the circumference of an outside of the plasma generating room 1, the composition in which the microwave power supply 6 is connected to the microwave introduction aperture 4 prepared in the upper part of the plasma generating room 1 through the waveguide 5 is the same as usual.

[0013] It is a product made from stainless steel, and is what was made owner top tubed [ which consists of a side attachment wall and an apical plate-], owner \*\*\*\* 19 made from carbon is fitted in the interior, and the plasma generating room 1 makes in agreement with the microwave introduction aperture 4 the opening 20 prepared in the center of an apical plate. Between the side attachment wall of owner \*\*\*\* 19 made from carbon, and the side attachment wall of the plasma generating room 1, it is equipped with the conductive connection ring 18, and owner \*\*\*\* 19 of the plasma generating room 1 and the product made from carbon is connected electrically.

[0014] For ten, as for RF bias power supply and 12, a substrate electrode holder and 11 are [ a flueing system and 14 ] substrates among drawing.

[0015] Next, drawing 2 is microwave plasma treatment equipment of the 2nd example. Since the fundamental composition which formed successively the plasma generating room 1 and the substrate conveyance rooms 2 is the same as that of the 1st example, the same sign is given to the same member and explanation is omitted.

[0016] Owner \*\*\*\* 21 made from carbon is fitted in the interior of the plasma generating room 1 made owner top tubed by the product made from stainless steel. this owner \*\*\*\* 21 -- an outer diameter -- the bore of the plasma generating room 1, and abbreviation -- it has supposed that it is the same and the annular flange 22 is formed in the soffit outside of a side attachment wall When the annular flange 23 formed in the soffit outside of the side attachment wall of the plasma generating room 1 puts on a flange 22 and a flange 23 is fixed in the substrate conveyance room 2, the flange 22 of owner \*\*\*\* 21 made from carbon is considering as the structure electrically connected with the plasma generating room 1 and the substrate conveyance room 2.

[0017] For ten, as for RF bias power supply and 12, a substrate electrode holder and 11 are [ a flueing system and 14 ] substrates among drawing.

[0018] In the above example, since it is the same as that of the conventional technology to process the front face of the substrate 14 which plasma-ized the raw gas and was laid in the substrate electrode holder 10 according to the interaction of microwave and a magnetic field, the explanation is omitted.

[0019] On the occasion of processing, the plasma generating room 1 and the substrate conveyance room 2 are grounded, and let them be ground potential. Therefore, owner \*\*\*\* 19 and 21 made from carbon installed inside the plasma generating room 1 also serves as ground potential. Consequently, when RF bias is impressed to the substrate electrode holder 10, owner \*\*\*\* 19 and 21 can act as a ground electrode for RF bias, and can attain stabilization of the plasma in the plasma generating room 1, respectively. Since repeatability is good, the ion in plasma is accelerated to desired level and a substrate 14 can be processed, stabilization of a processing property, i.e., an etching property, and a membrane formation property can be attained.

[0020] Drawing 3 is SiO<sub>2</sub> formed in the front face of the substrate 14 which is equipment conventionally which was shown in the equipment and drawing 5 of the 1st example, and becomes with a silicon wafer. The etch rate when performing receiving etching and the homogeneity within a field are expressed. Similarly an etch rate in case a is equipment of the 1st example, and b are the homogeneity within a field among drawing, and, similarly an etch rate in case c is equipment conventionally, and d are the homogeneity within a field. According to the equipment of an example, it compares with equipment conventionally so that clearly from drawing, and they are about 3600Å / min about an etch rate. Such repeatability was also able to be improved while the homogeneity within a field could also improve with about \*\*3% highly.

[0021] Owner \*\*\*\* 19 and 21 made from the aforementioned carbon is the gas of the chlorine system used, for example by etching of polycrystal silicon since it considers as ground potential, or a fluorine system, and SiO<sub>2</sub>. Although a spatter will be received with the ion in the plasma of the gas of the fluoridation carbon system used by membranous etching, since the resultant is volatility, there is no possibility that a substrate 14 may be polluted.

[0022] On the other hand, although depositing the resultant at the time of membrane formation also on internal parts other than a substrate is not avoided when the equipment of an example is used as a CVD system, since owner \*\*\*\* 19 and 21 made from

carbon is simple structure, cleaning can be completely [ easily and ] possible, the particle produced by ablation of a sediment can be lost, and it can prevent that a substrate is polluted.

[0023] In addition, although owner \*\*\*\* 19 and 21 was made into the product made from carbon in the example, it may constitute from nonmetallic conductors, such as silicon and a silicon carbide, or you may constitute from composite material of nonmetallic conductors, such as carbon, silicon, and a silicon carbide.

[0024] Moreover, although it connected with the plasma generating room 1 electrically and owner \*\*\*\* considered as ground potential, it is also possible to make it connect with ground potential with wiring.

[0025] Drawing 4 is the example of drawing 2 , and when O ring 24 is used for the flange 23 of the plasma generating room 1, and the vacuum seal portion of the substrate conveyance room 2, in order to secure the ground potential of owner \*\*\*\* 21 made from carbon, it is the example which used the spiral shield 26 between the flange 22 of owner \*\*\*\* 21, and the substrate conveyance room 2. It is made to have flowed through the substrate conveyance room 2 of owner \*\*\*\* 21 made from carbon, and ground potential through metal coil 26a of the spiral shield 26.

[0026]

[Effect of the Invention] It is effective in realizing the good microwave plasma-treatment equipment of the maintenance nature which the plasma stabilized when this invention was wearing wall surfaces other than the microwave introduction window part part of a plasma generating room in microwave plasma-treatment equipment by the wall which consists of conductive material other than a metal and the composition with which this wall connects with ground potential electrically was used for it, as having explained above is acquired, and impurity contamination does not generate.

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[Translation done.]